DISCUSSION.

IS THE LAND AROUND HUDSON BAY AT PRESENT RISING?

In the preceding note, H. C. Cooke has expressed some doubt concerning the present author's conclusions relative to the rate of uplift of the land in the Hudson Bay region. Cooke's remarks refer to the findings based on the tide gauge readings at Churchill as well as to field evidence.

The method by which the present author arrived at his results concerning the mean change in sea level at Churchill unfortunately was not stated in his paper. It was not the procedure described by Cooke and used by the author for most calculations, but the method of least squares was applied to all monthly averages of sea level, separately for each month, under the assumption that the changes are proportional to time. That this is a good first approximation, is indicated by the following table giving deviations in hundredths of feet from the "mean level, average of all 30 day periods to 1938 inclusive" as given to the author by the Canadian Hydrographic Survey, with the addition of the data for 1940. The figures are the same as those given by Cooke.

	June	July	Aug.	Sept.	Oct.	Nov.
Average 1928-1931	?	+21[1]	+ 6[3]	+18	+38	+30[3]
1932-1934	+12[2]	− 8[2]	+31	+12	+28	+34[5]
1935-1937	−35	−33	−34	−10	?	?
1938-1940	−50[4]	−54	−57	−39	−52	−81[4]

[1] 1930-1931 [2] 1933-1934 [3] 1929-1931 [4] 1939-1940 [5] 1932, 1934

For the period 1928-1940, a calculation based on all the data of the table indicates a change in sea level at a rate of about $2\frac{1}{2} \pm \frac{3}{4}$ meters per century; for the months August to October alone, the resulting rate is about $2\frac{1}{4} \pm \frac{3}{4}$ meters per century.

The author considers his conclusion—"the present rate of uplift . . . exceeds one meter per century and is probably nearer two meters per century; even a value of three meters . . . must be considered as possible"—as conservative. He does not agree with the statement by Cooke that the gauge readings indicate a "sudden break of nearly a foot" in August or September, 1934, and maintained "a reasonably constant level for the next six years." A change of nearly one foot late in 1934 should be indicated by a difference of nearly 100 between the figures in the second and third lines in the table. On the other hand, the last two lines in the table indicate that after 1934 the sea level continued to decrease at a rate corresponding closely to the average of about $2\frac{1}{2}$ meters per century.

The calculated change in sea level is scarcely influenced by the fact that the tides must fight their way into the harbor or by the difference in the height of the tides, inside and outside the harbor. There can be little doubt that in the average of 13 years the effects of the location of the gauge and of the river flow, at least during the late summer, on the calculated large change in sea level in the harbor are relatively small. They certainly influence somewhat the variations in the calculated rate. On the other hand, such variations have been found in other regions with more extensive data. In his paper under discussion (l.c. p. 745), the author has given some data for the Great Lakes region, where for certain periods, covering a few years each, the tilt has practically stopped, or where the data even suggest the possibility of an occasional reversal of the tilt for a few years in a limited area. Of course, the tide gauge data furnish only the *present* rate of uplift; the average rate during the past centuries can be found only from field data.

In his second part of his note, Cooke discusses such observations in the field made in 1893 by Tyrrell. The fact that the base of the walls of Fort Prince Wales, built in 1733, were 17 feet above spring tides and 6 feet above the level reached by storm waves at high tide about 1893 (after about 160 years) would not exclude a decrease in sea level by about 1¼ meters (4 feet) per century on the assumption that the foot of the walls remained dry during the highest waves. If no local changes have occurred, an average rate of 2 meters per century (about 10 feet in 160 years) would lead to the result, that in 1733 the base of the walls was 7 feet above normal spring tides but that the highest storm waves reached about 4 feet above the base of the walls. Whether this is possible or not depends on the locality and the building. On the other hand, an account published in 1744, states, according to Tyrrell, that the Fort was built upon an eminence, 40 feet high. Tyrrell considers this a "natural exaggeration." The fact that in 1741 ships could enter Sloops Cove, with its mouth now only a few feet deep, excludes a sinking of the land. Certainly there is an error or misinterpretation somewhere.

Tyrrell's comparison between a map made in 1736, with the conditions in 1893 seems to indicate that the uplift during the 160 years after 1746 could not have exceeded a few feet. On the other hand, he mentions that the place of a bridge "has since been taken by a sandy bar . . . built by currents." Could this not, instead, be an indication of the rising of the land? Also, the effects of erosion and sedimentation should be considered. Tyrrell's findings based on data related to "Sloops Cove" have been discussed by the author l.c. p. 749) who points out that any conclusion is "uncertain" and that the data available do not exclude an uplift of the land exceeding even 10 feet in 180 years. Whether the bottom of the cove has

risen by silting, or not, does not influence this result. No additional evidence is cited by Tyrrell. On the other hand, the author, (l.c. pp. 748-750) has referred to publications by other authors, nearly all of whom reach the conclusion that the field evidence strongly indicates a rather rapid uplift of the Hudson Bay area during the past centuries. The data for Churchill are not so much needed to establish this fact as to aid in the location of the center of the uplift.

REFERENCES.

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